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Title: Pearson correlation coefficients applied to correlated physics of fission

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Pearson correlation coefficients applied to correlated physics of fission

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Pearson correlation coefficient

- Can range from completely anti-correlated (-1), to uncorrelated (0), to completely correlated (1)

$$r = \frac{\sum_{i=1}^n (x_i - \bar{x}) (y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2} \sqrt{\sum_{i=1}^n (y_i - \bar{y})^2}}$$

- Definitions:
 - n is the number of codes being compared
 - x_i is the value of a single observable of interest for the i^{th} code
 - y_i is the value of a single nuclear data item of interest for the i^{th} code
 - \bar{x} is the mean of all values of x
 - \bar{y} is the mean of all values of y

Applied to correlated physics of fission

- Observables of interest:
 - Singles (R_1)
 - Doubles (R_2)
 - Leakage multiplication (M_L)
- Nuclear data items of interest:
 - Mean of spontaneous fission $P(\nu)$
 - Width of spontaneous fission $P(\nu)$
 - Mean of induced fission $P(\nu)$
 - Width of induced fission $P(\nu)$

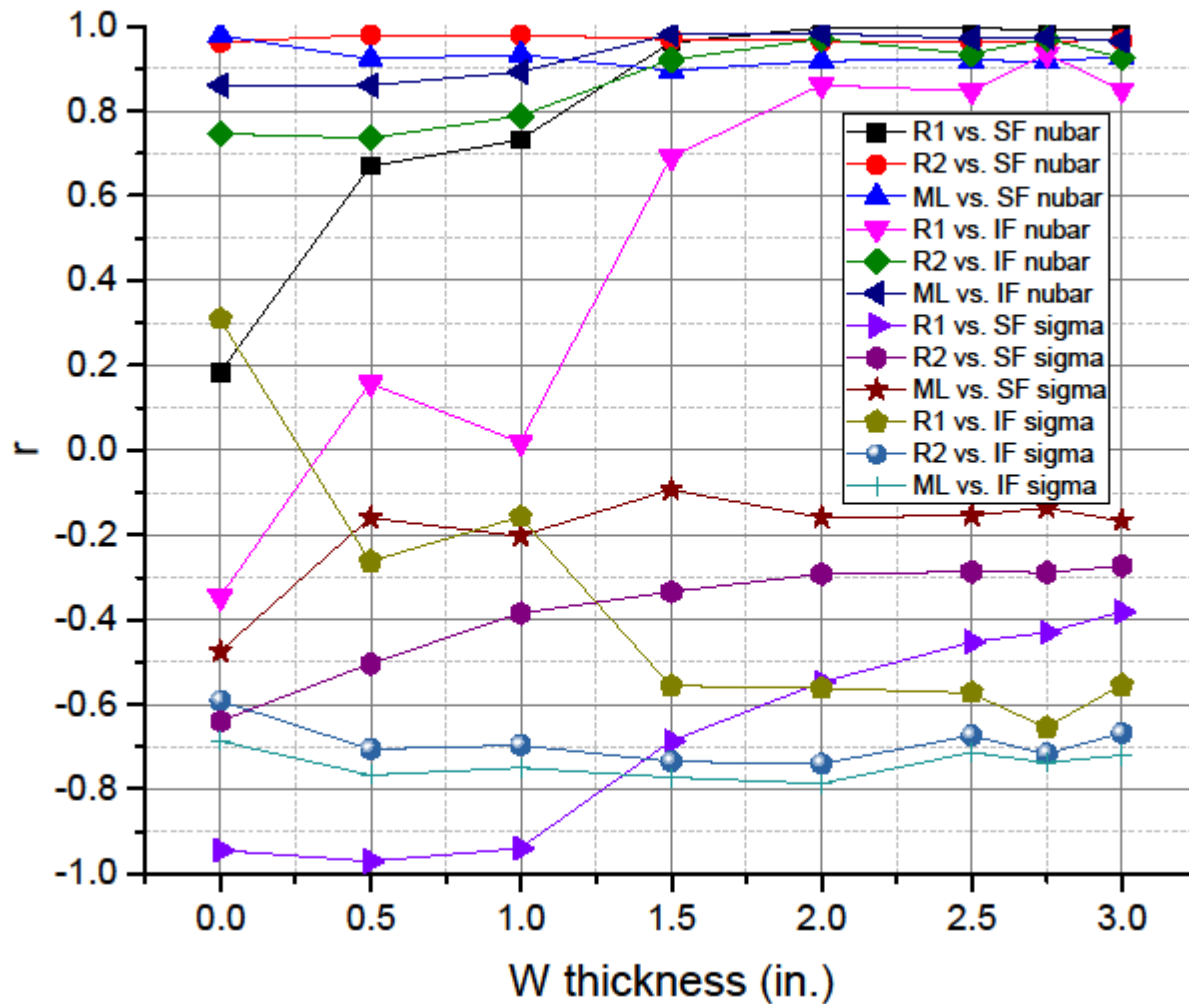
Applied to correlated physics of fission

- Observables of interest:
 - Singles (R_1)
 - Doubles (R_2)
 - Leakage multiplication (M_L)
- Other nuclear data items of interest:
 - Mean of spontaneous fission $\chi(E)$
 - Width of spontaneous fission $\chi(E)$
 - Mean of induced fission $\chi(E)$
 - Width of induced fission $\chi(E)$

Models

- Calculated correlation coefficients for:
 - All BeRP-W benchmark simulated configurations
 - Between MCNP6.2, MCNP6.2/FREYA, MCNP6.2/CGMF, and PoliMi
- All spontaneous fission assumed to come from Pu-240, and all induced fission from Pu-239

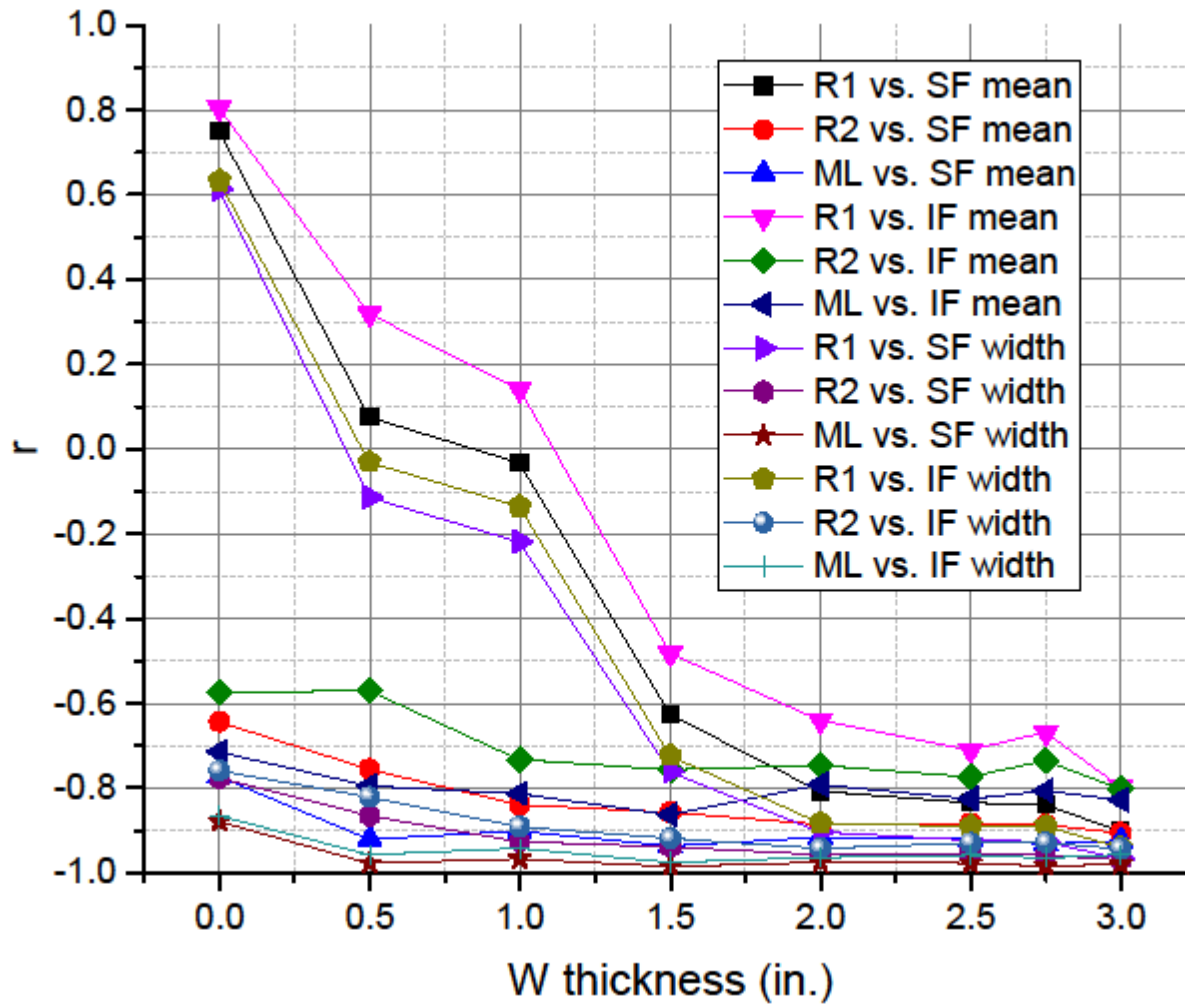
P(v) results



$P(\nu)$ results

- Consistently large correlations between:
 - R_2 and SF $\bar{\nu}$
 - M_L and SF $\bar{\nu}$
 - R_2 and IF $\bar{\nu}$
 - M_L and IF $\bar{\nu}$

$\chi(E)$ results



$\chi(E)$ results

- Consistently large anti-correlations between:
 - M_L and IF $\chi(E)$ mean
 - M_L and SF $\chi(E)$ mean
 - R_2 and SF $\chi(E)$ width
 - M_L and SF $\chi(E)$ width
 - R_2 and IF $\chi(E)$ width
 - M_L and IF $\chi(E)$ width

Conclusions

- Interesting correlations exist between observables of interest and correlated physics of fission nuclear data items of interest
- $P(\nu)$ correlations are included in correlated physics Annals of Nuclear Energy submitted paper
- $\chi(E)$ correlations to be included in thesis